# Josephson Qubits in a Microcavity

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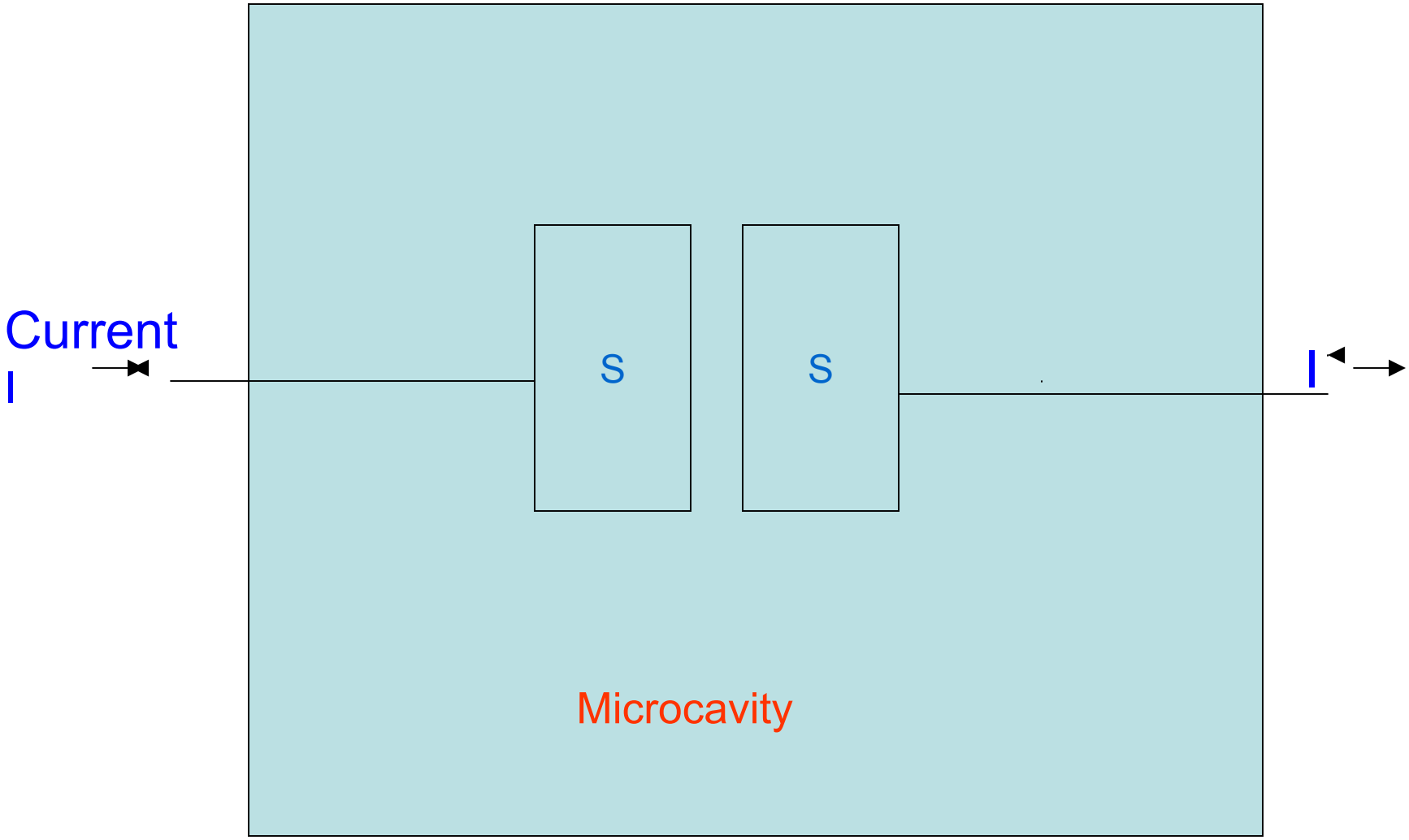
- A qubit, or ``quantum bit'' is part of a hypothetical quantum computer which can do calculations millions of times faster than our usual computer
- The computer on our desk uses ``classical bits'' in which information is stored as a ``yes'' or ``no''
- With a qubit, we can have a mixture of ``yes'' and ``no'', so much more information can be stored in the same space.

# Small Josephson junctions as qubits

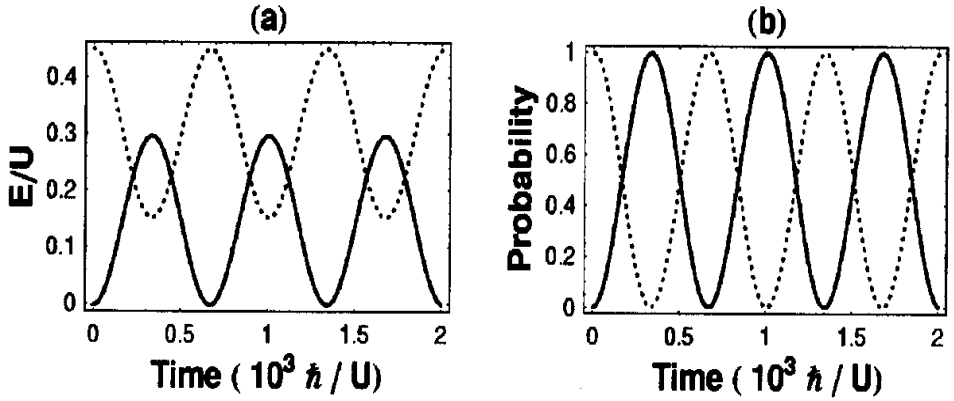
- Small superconducting systems (i. e. Josephson junctions) are among the most promising candidates for use as qubits
- They are promising, because, if they are small enough, they have just two energy levels (which behave like ``yes'' and ``no''.
- We are considering a particular class of such Josephson systems, namely, a small junction in a tiny cavity. This, too, has just two energy levels and can be even more easily controlled than a Josephson junction by itself.

# Quantum bit (qubit) made of a small Josephson junction in a microcavity




Josephson junction is two superconductors (S and S) separated by insulating region

# Time-dependent behavior of junction-cavity qubit




On the left, energy in junction (solid line) and in cavity (dashed line) oscillates in time. On the right, probability that junction (solid line) and cavity (dashed line) is in first excited state. Oscillations mean this is a good qubit.

# Summary

- Small Josephson junctions + microcavity can be modeled microscopically
- They are very promising for quantum information processing
- Current work: extend these results to more than one qubit (``scalable computing'') and different geometries (``flux qubits'')
- I will present this work as invited talk at national APS meeting in March

# Educational Activities of this Project

- Principal Investigator: David Stroud
- Two postdoctoral researchers: Dr. Sung Yong Park and Dr. Hayoun Lee
- Eight graduate students: G. Mohler, E. Almaas, S. Barabash, W. Al-Saidi, I. Tornes, D. Valdez-Balderas, K. Kim, K. Kobayashi
- Three international collaborators: D. J. Bergman (Tel-Aviv Univ.), Y. Strelniker (Bar-Ilan Univ.), P. M. Hui (Chinese U. of Hong Kong)